AGRICULTURAL EXPERIMENT STATION

KANSAS STATE AGRICULTURAL COLLEGE
MANHATTAN, KANSAS.

DEPARTMENT OF BOTANY.

IMPERIAL BUREAU 17 AUG. 1925 OF MYCOLOGY

THE COPPER CARBONATE DUST METHOD OF CONTROLLING BUNT OF WHEAT.[1]

L. E. MELCHERS AND H. B. WALKER.

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BUNT (STINKING SMUT) OF WHEAT IN KANSAS.

Bunt (stinking smut) of wheat causes considerable loss in Kansas. It may occur in epidemics some seasons, but generally smaller quantities are present in various counties each year. The damage occurs in two ways. First, a direct loss in yield. In Kansas this may vary from a few per cent to 75 per cent of the crop in a field. Second, a small percentage of smut contaminates the remainder of the grain so that it has less value for milling and seed purposes. Records over a number of seasons show that the average annual loss in Kansas is approximately one million dollars.

Wheat seed treatment has not been a common practice in this state, chiefly because of the fact that it requires labor and expense, but also because bunt is sporadic in its occurence and does not occur in epidemics each year. Since many Kansas farmers have had little loss from bunt, naturally seed treatment has not been as extensively or consistently practiced as in California, Washington,

NOTE.—L. E. Melchers is Plant Pathologist of the Agricultural Experiment Station, and H. B. Walker, Agricultural Engineer of the Engineering Experiment Station, Kansas State Agricultural College.

1. Contribution No. 223 from the Department of Botany.

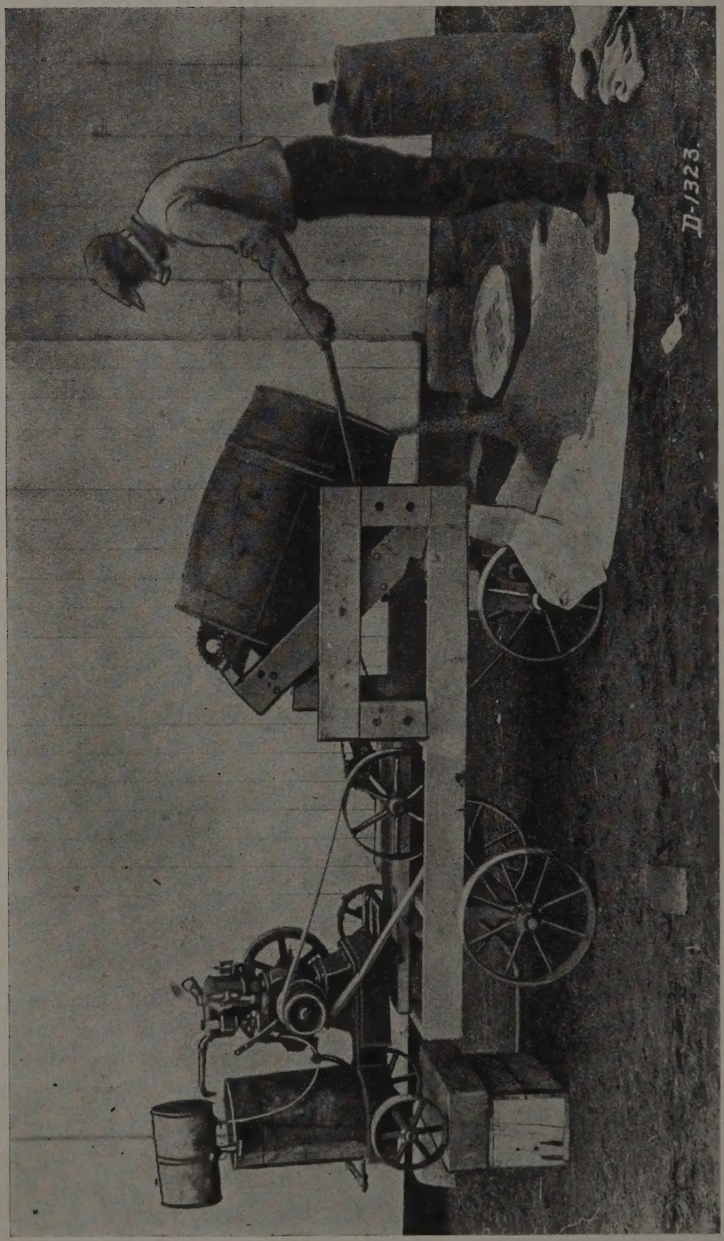

FIG. 1.—A concrete mixer supplied with a dust-tight lid; a satisfactory dusting machine.

and Oregon, where wheat smut is very serious each year and where seed treatment is absolutely necessary.

The treatment of seed wheat has always been recommended as an "insurance policy" against bunt in Kansas, since it is impossible to tell when an epidemic will occur. A small quantity of bunt spores on the seed is sufficient to cause a large loss the following season if soil conditions are right for infection to occur at seeding time. Such was the case in 1920 and 1921 when considerable bunt appeared in the wheat crop.

METHODS OF CONTROL COMMONLY USED.

The standard wet formaldehyde treatment has been most commonly used in Kansas. The copper sulphate or blue vitriol method has been used to some extent, but it has given less favorable results than the formaldehyde treatment. Both of these methods have the disadvantage of wetting the seed. This no doubt is partly responsible for their limited use. It has been observed in this state that the formaldehyde method when carefully used will give satisfactory control of bunt and practically no injury to the seed will result. Copper sulphate has caused more injury to the seed than formaldehyde and for this reason it has not been recommended.

THE COPPER CARBONATE DUST METHOD OF CONTROL.

The Kansas Agricultural Experiment Station has been conducting experiments for four seasons with a new method known as the copper carbonate dust treatment. This method has been used in different countries, and for the last few years it has been extensively used in California, Washington, and Oregon with satisfactory results. It is also being used to some extent in Minnesota and Michigan. Since climatic conditions from season to season vary greatly in Kansas, it became necessary to conduct experiments during several seasons and hence under various climatic conditions to find out what merits the copper carbonate dust method has here. Results show that it has some distinct advantages over the wet methods and that it can be used with safety for treating wheat to control stinking smut. Even the copper carbonate dust method has certain limitations and these must be considered carefully by the grower.

The copper carbonate dust method consists of mixing thoroughly the *fanned seed* with this chemical dust at the rate of two ounces of the dust to one bushel of wheat. *The dust must be thoroughly*

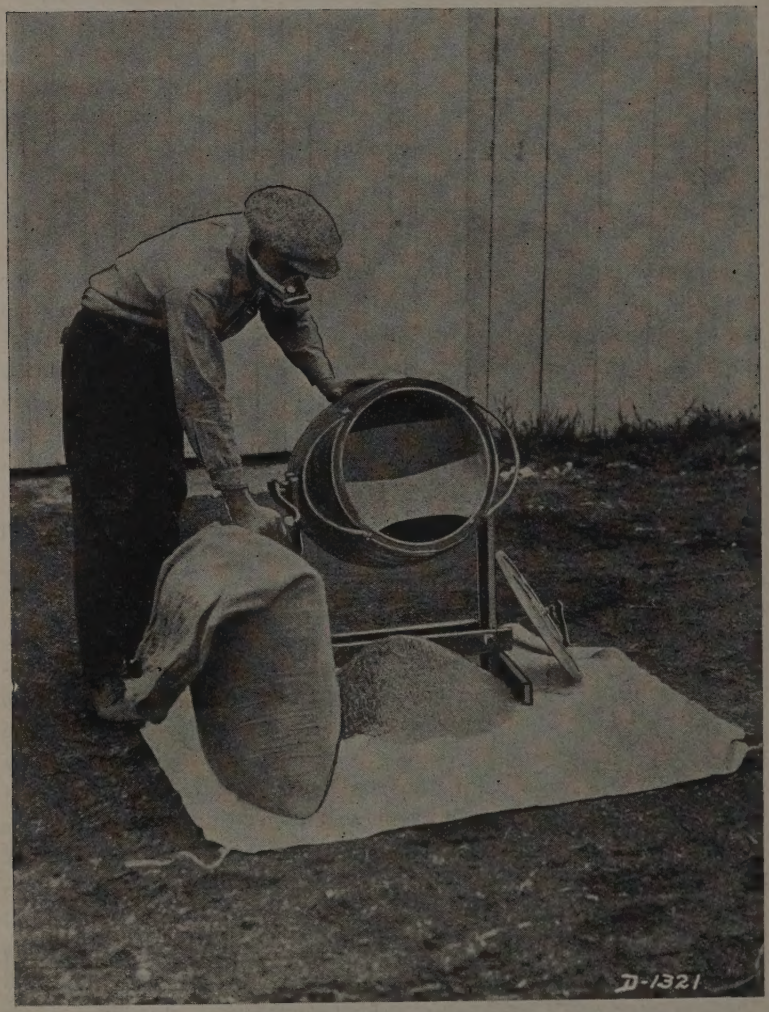

FIG. 2.—A 20-gallon churn fitted with agitator for use as a dusting machine.

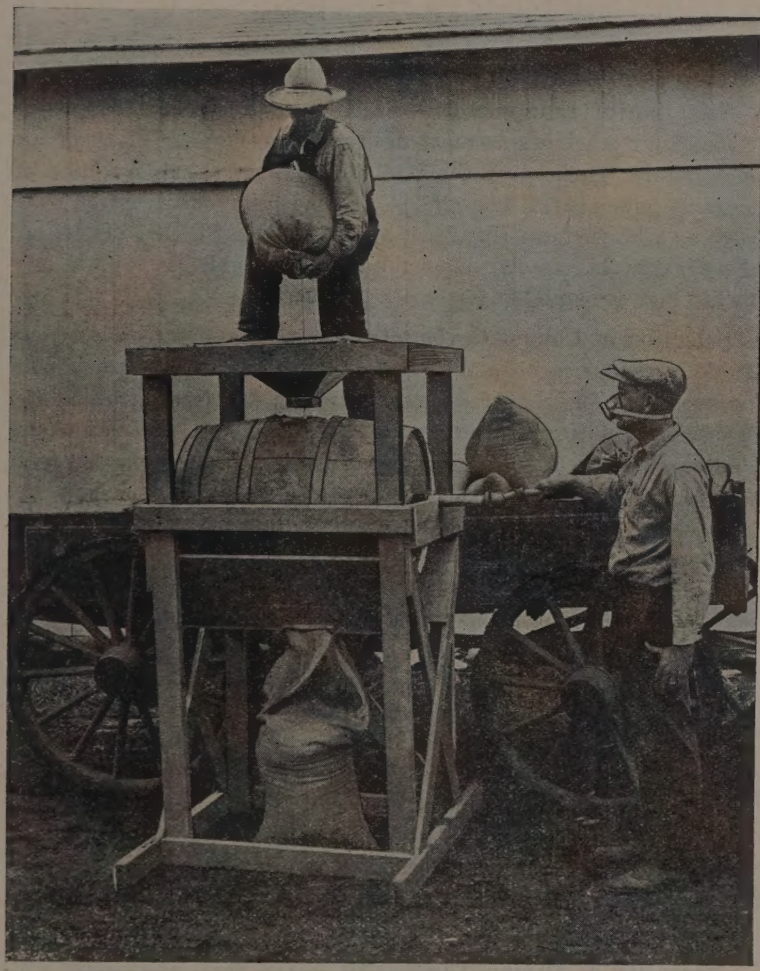

FIG. 3.—A dust-treating machine made by using a barrel and other materials available on the farm.

mixed so that every kernel has some of the copper carbonate adhering. This is accomplished by using any one of a number of machines or devices which may be purchased on the market or made on the farm, and which are described herein.

SUGGESTIONS REGARDING THE COPPER CARBONATE DUST TREATMENT.

Selection of Equipment.—For large acreages one of the large commercial machines is most desirable. A number of them are now on the market. A concrete mixer (fig. 1), run by hand or gasoline power is satisfactory. A less expensive outfit can be used, such as a large churn (fig. 2) or a barrel mixer (fig. 3). These are described in this circular under the heading, "Smut-Treating Equipment" and are suitable for small acreages.

Selection of Copper Carbonate.—It is necessary to use a good grade of copper carbonate. Inferior copper carbonate dusts should be avoided. The copper carbonate used in the experiments at the Kansas Agricultural Experiment Station was 90 to 98 per cent pure and analyzed from 50 to 55 per cent metallic copper. However, it should be stated that some dusts which are being placed on the market have a smaller copper content, but nevertheless possess distinct merits. These are sold under various trade names. *Ninety per cent of the dust should be able to pass through a 200-mesh screen.* The fineness is as important as the chemical constituents, since it is absolutely essential that a fine film of dust cover the entire surface of the grain. The density, after shaking down dry, should not be over 32 pounds per cubic foot. The color should be light green, not blue, and the dust must be free from lumpiness. There are on the market many grades of copper carbonate, both pure and impure. Since it is impossible for the Agricultural Experiment Station to test all of these compounds, it will be well for the wheat grower to secure as much information concerning their merits as possible. Whenever information is available, the station will be glad to supply it.

Necessity of Mixing Thoroughly.—The grain and copper carbonate dust must be mixed sufficiently to make it absolutely certain that each grain is covered with dust. This may be mechanically accomplished by mixing machines which are now on the market. It will require at least 1½ minutes to mix a batch of seed with a concrete mixer or piece of home-made equipment. The

amount of seed treated at one time depends upon the capacity of the equipment used.

The Amount of Copper Carbonate to Use. — For ordinary smutted seed, two ounces of copper carbonate to the bushel of seed is sufficient. Some manufacturers recommend more than two ounces, depending upon the make of copper carbonate. The dust can be measured by means of a tablespoon, since a heaping tablespoonful will weigh very close to an ounce.

When Not to Use the Copper Carbonate Dust Method.—*If the seed is black with smut, use the standard formaldehyde treatment which is more effective than the copper carbonate method under such conditions.* Complete control of wheat smut has not been obtained when very badly contaminated seed has been treated with copper carbonate dust.

The Operator Should Be Protected.—*Do not inhale the copper carbonate dust, as it causes nausea and irritations.* These can be avoided by wearing a dust mask or by placing a wet handkerchief over the nose and mouth. Treat the grain in the open air when possible. Dust masks similar to those used in certain factories or mills, as prescribed by state law, are satisfactory.

Possibilities in Commercial Machinery. — Commercial machinery can be installed at reasonable expense in warehouses and elevators. With such an arrangement the seed wheat could be treated for the farmer. The actual cost is only a few cents a bushel.

Further Information.—For further details concerning equipment, sources of copper carbonate, dust masks or other information concerning construction of equipment or treatment of seed wheat write to the Agricultural or Engineering Experiment Stations, K. S. A. C., Manhattan, Kan., or consult a county agricultural agent.[2]

THE ADVANTAGES OF THE DUST METHOD.

1. Seed can be treated at any time of the year and stored without danger from injury. The germination is not affected. No extra seed per acre has to be planted.

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2. The reader is also referred to the following publications for additional information on the copper carbonate dust method: (1) Bulletin 364 of the California Agricultural Experiment Station (Berkeley, Cal.), "Fungicidal Dusts for the Control of Bunt," by W. W. Mackie and Fred N. Briggs; and (2) Bulletin 168 of the Washington Agricultural Experiment Station (Pullman, Wash.), "The Dusting of Wheat for Bunt or Stinking Smut," by F. D. Heald and L. J. Smith.

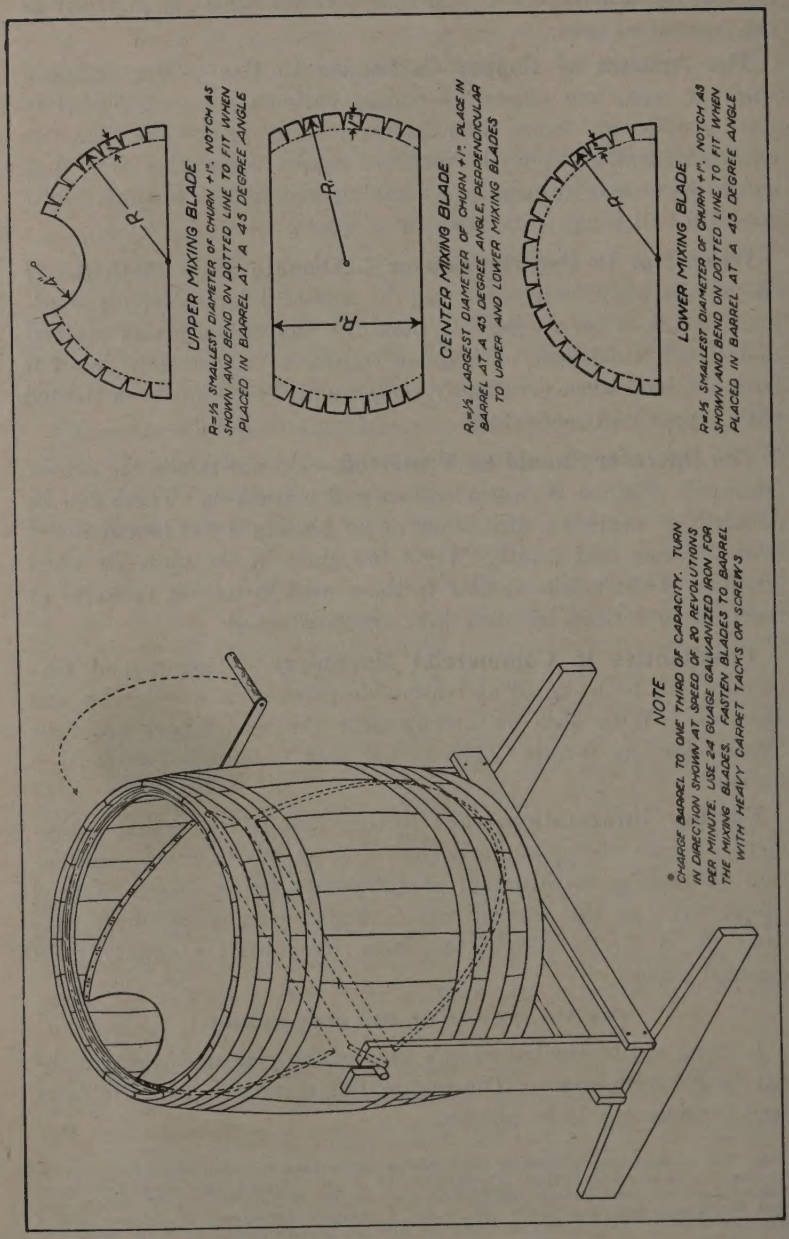
UPPER MIXING BLADE
R=⅓ SMALLEST DIAMETER OF CHURN +½". NOTCH AS SHOWN AND BEND ON DOTTED LINE TO FIT WHEN PLACED IN BARREL AT A 45 DEGREE ANGLE
CENTER MIXING BLADE
R=⅓ LARGEST DIAMETER OF CHURN +½". PLACE IN BARREL AT A 45 DEGREE ANGLE, PERPENDICULAR TO UPPER AND LOWER MIXING BLADES
LOWER MIXING BLADE
R=⅓ SMALLEST DIAMETER OF CHURN +½". NOTCH AS SHOWN AND BEND ON DOTTED LINE TO FIT WHEN PLACED IN BARREL AT A 45 DEGREE ANGLE
NOTE
*CHARGE BARREL TO ONE THIRD OF CAPACITY. TURN IN DIRECTION SHOWN AT SPEED OF 20 REVOLUTIONS PER MINUTE. USE 24 GUAGE GALVANIZED IRON FOR THE MIXING BLADES. FASTEN BLADES TO BARREL WITH HEAVY CARPET TACKS OR SCREWS

Fig. 4.—Plans for churn smut-treating machine.

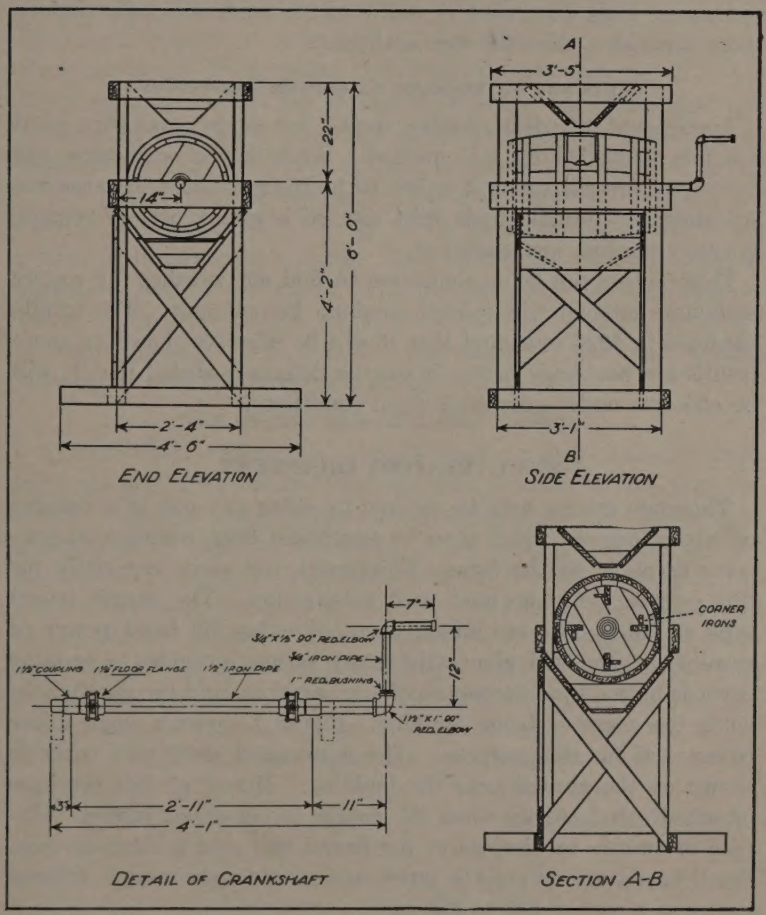

FIG. 5.—Plans for barrel smut-treating machine.

2. The dusted seed can be planted at any time in dry or moist soil. Observations indicate that a better stand is secured and the grain germinates more quickly than with untreated seed.

3. It requires very little labor or expense to treat seed for large acreages. This treatment is much more rapid, although slightly more expensive, than the wet methods.

SMUTS NOT CONTROLLED BY COPPER CARBONATE.

Loose smut of wheat, barley smuts, oat smuts, and corn smut are not controlled by this method. While copper carbonate has been used for oat smut, it is not to be recommended, because the so-called dry formaldehyde mist method is giving perfect control, is easily applied, and costs less.

Experiments are being conducted to find out whether the copper carbonate method will control sorghum kernel smut. The results obtained in 1923 indicated that it will be effective; however, more results are necessary before it can be definitely stated that it will be effective under prevailing farm conditions.

SMUT-TREATING EQUIPMENT.

Thorough mixing may be secured by using any one of a number of mixing devices which may be purchased from commercial concerns or made on the farm. Equipment, not made especially for this purpose, may be used with satisfaction. The simple barrel type of batch concrete mixer, operated either by hand power or gasoline engine, will give satisfactory service provided a suitable cover is placed over the mouth of the barrel to hold the dust within while the wheat is being agitated. Figure 1 shows a small mixer being used for this purpose. The improvised sheet iron cover is shown on the ground near the building. Mixers of this type are operated satisfactorily when the charge is about one bushel. Fifteen or twenty revolutions of the barrel will give a thorough mix. Small barrel mixers may be purchased on the open market without power at a cost of $30 to $50 each.

THE CHURN SMUT-TREATING MACHINE.

A mixer of small capacity may be made readily from a barrel churn as shown in figure 2. This is made by using the ordinary type of 20-gallon, or larger, barrel churn and inserting mixing blades of sheet steel as shown in figure 4. The patterns for cutting and bending the blades are also indicated. The lower mixing blade

is placed near the bottom at an angle of 45° with the floor of the churn. The center blade has a width equal to half the largest diameter of the churn, but it is placed in the center with both sides open, and with the plane of the blade at right angles to the plane of the lower blade. The upper blade is placed near the head of the churn forming an angle of 45° with the top, and parallel to the lower blade. It is similar to the lower blade with the exception of an opening next to the staves to facilitate the draining of the wheat after the charge has been sufficiently mixed. Large carpet tacks, or small screws, may be used to fasten the blades in place.

The position of the blades is such that when the churn is revolved as indicated by the arrow in figure 4, the contents are stirred as if turned in a scoop. This thoroughly mixes the copper carbonate with every grain. The proper charge for this type of mixer is three pecks and the churn should be operated at a rate of approximately 20 revolutions per minute. Thorough mixing requires at least one and one-half minutes of time.

THE BARREL SMUT-TREATING MACHINE.

A home-made mixer may be made from a vinegar barrel. Ordinary gas pipe with standard fittings may be used for the axle and crank. Figure 5 shows a plan of construction of this barrel type which may be modified somewhat if all materials shown are not available. This mixer has a capacity of one bushel per charge. For thorough mixing, the barrel should be revolved at a rate of about 20 revolutions per minute. When equipped with the upper and lower grain hoppers the operation is both rapid and convenient. The cost of materials for construction as shown is about $15. The pipe and fittings may be made up in any plumbing shop. The framing can be easily made up if the directions for construction are carefully followed.

Bill of Materials.

The following materials may be purchased from local merchants if not already available on the farm:

No.	Size.	Length.	Grade.	Remarks.
1	2″ x 6″	12′	No. 1 dimension	Framing.
3	2″ x 4″	12′	No. 1 dimension	Framing.
1	2″ x 4″	16′	No. 1 dimension	Framing.
1	1″ x 10″	12′	No. 1 shiplap	Hoppers.
1	1″ x 8″	12′	No. 1 shiplap	Hoppers. ,
1	1″ x 4″	14′	No. 1 boards	Mixing blades and braces.
1	1″ x 4″	14′	No. 1 boards	Mixing blades and braces.
1	1½″	11′	Iron pipe	Crankshaft.
1	½″	2′	Iron pipe	Crank.
1	1″	10″	Iron pipe	Handle.
2	1½″	2″	.....	Couplings.
1	1½″ x ¾″	...	.....	90° reducing elbow.
1	½″	...	.....	90° elbow.
1	¾″	...	.....	Reducing bushing.
1	½″	...	.....	Cap.
4	1¼″ x 4½″	...	.....	Floor flanges.
8	⅞″ x 4″	...	.....	Corner irons.
8	¼″	2″	.....	Stove bolts.
32	.....	1″	.....	Wood screws.
2 lbs.	16d	...	Common	Nails.
1 lb.	8d	...	Common	Nails.
1	.....	...	Standard	Vinegar barrel.

Directions for Building.

Cut the four corner posts, each 6′ long, from two of the 2″ x 4″ x 12′ material. Cut two top end framing pieces each 2′ 4″ long and two top side framing pieces each 3′ 5″ long from the 2″ x 4″ x 12′ material. Nail side framing to end framing, forming a rectangle with inside dimensions 2′ 4″ wide by 3′ 1″ long. Use 16d nails. Square the corners carefully.

Cut two lower end framing pieces each 4′ 6″ long and two lower side framing pieces each 3′ 1″ long, from the 2″ x 4″ x 16′ material. Nail the end framing to the side framing to form a rectangle with inside dimensions 2′ 4″ wide by 3′ 1″ long. Note that the end framing pieces project beyond side framing to form base support. Square the corners carefully and nail, using 16d nails.

Place the 2″ x 4″ x 6′ posts in position between the rectangles with the 4″ dimension along the side of the frame and the 2″ dimension along the end, as shown by figures 3 and 5, and nail securely to upper and lower frames using 16d nails.

Cut two intermediate side framing pieces each 3′ 5″ long and two intermediate end framing pieces each 2′ 4″ long from the 2″ x 6″ x 12′ material. Bore a 2″ hole, centered 14″ from the end and 1″ from the top side, through each of the two end framing pieces to form the bearing for the crankshaft. Nail these two intermediate pieces to

the corner posts with upper side 22″ from the top of the posts as shown by the plan (Fig. 5). Use 16d nails.

Cut two diagonal end braces from one of the 1″ x 4″ x 12′ boards and one diagonal end brace from the remaining 1″ x 4″ x 12′ board. The fourth diagonal end brace is cut from the 1″ x 4″ x 14′ board. Square the frame carefully and nail the end braces to inside of end posts using 8d nails. Note that the end braces must be high enough on the posts that the shiplap, when placed in position, will have its upper edge flush with the lower inside edge of the 2″ x 6″ intermediate side framing pieces.

Cut the two diagonal side framing pieces from the remaining part of the 1″ x 4″ x 14′ board. Square framing carefully and nail securely in place on outside posts as shown on the plan. Use 8d nails. Now cut two pieces from the 1″ x 10″ x 12′ shiplap and two pieces from the 1″ x 8″ x 12′ shiplap to fit between the side posts to form the sides of the lower grain hopper. Place one 1″ x 10″ and one 1″ x 8″ piece on each side and nail these securely to end braces with 8d nails. With the sides of the hopper now formed the ends may be built from the 1″ x 10″ and the 1″ x 8″ shiplap. Cut these to fit when placed to slope downward at an angle of about 30° to center. Use 8d nails.

Bore a 2″ hole through the center of the top and bottom barrel heads. Remove one head from the barrel being careful to avoid breaking the boards since this head must be replaced after the mixing blades and crankshaft are in position. Cut an opening inside of barrel at center selecting a combination of two staves which will give the largest opening without cutting any staves entirely in two. Make the opening approximately square. The ends of the opening should be about ⅝″ from the center barrel hoops.

To form a covering for the barrel opening cut two strips of galvanized iron about 1¼″ wide and 1″ longer than the opening. Bend the strips at right angles along their length and fasten with suitable screws to the outside of the barrel along the opening. Cut another strip 1¼″ wide with a length equal to the distance between the adjacent barrel hoops and bend as above. Attach to barrel by means of suitable screws at top of opening, placing this strip under the ends of the two side strips.

Cut a galvanized iron lid to fit between the upturned edges of side strips and make this about 3″ longer than the opening. Place this over the opening and with hammer or mallet bend the side strips over the cover. Then bend the end strip over the end of the side

strips and over the cover. These side strips and end strips now form a guide for the door, the lower end of which may be bent to form a handle for opening and closing.

Cut four mixing blades each 2′ 3″ long from the remainder of the 1″ x 4″ boards. Fasten the corner irons to the mixing boards, with suitable screws, in such a manner that the lower irons screw fast to the bottom head of the barrel and the upper irons to the staves of the barrel. Space these four blades equidistant around the inside of the barrel. Place the center section of the crankshaft in the barrel with both inside flanges screwed in place. Next replace the barrel head, then screw the outside flanges snugly against the barrel heads. When these are both in place bore holes for bolts through the flanges to fasten the flanges to the barrel head and then screw the inside flanges against the inside faces of the barrel heads so that the holes in both flanges coincide. Bolt the flanges securely in place and then complete the crankshaft assembly as shown by the plan. (Fig. 5.) The barrel may now be placed in the frame.

The upper grain hopper may now be built from the 1″ x 8″ and 1″ x 10″ shiplap. This hopper is 10″ square at the top, 6″ square at the bottom and 9″ deep. The sides slope to the center at an angle of approximately 45°. The dimensions given are approximate outside dimensions. The boards making up this hopper must be carefully sawed and fitted. Use 8d nails.

The hopper must be so placed that it will center directly over the outside door to the barrel when the door is removed for filling. Note that the ends of the upper side pieces of the hopper are left square in order that they may support the hopper in the 1″ x 2″ cleats which are nailed to the sides of the main frame as indicated in the plan.

The tools required for the construction of this smut-treating equipment are: Claw hammer, hand crosscut saw, keyhole saw, square, pipe wrench, tinners snips, brace, and bits.

PRINTED BY KANSAS STATE PRINTING PLANT
B. P. WALKER, STATE PRINTER
TOPEKA 1924
10-3644